METHOD FOR MAKING MAGNETRONS

BACKGROUND OF THE INVENTION

The present invention relates to a method for making magnetrons. More specifically, the present invention relates to a method for making magnetrons used in radars, microwave heating devices, e.g., microwave ovens, or the like.

Referring to Fig. 4, a conventional magnetron includes a plurality of vanes 52 formed within a cylindrical anode cylinder 51. An anode vacuum container 55 includes a magnetic piece 53 and a metal container 54 disposed at the open end section of the anode cylinder 51. A cathode 57, disposed along the center axis of vacuum container 55, includes a top hat 56a, an end hat 56b, and a filament 56c. An antenna 58 extracts a microwave, e.g., at 2450 MHZ, generated in the hollow space. In this magnetron, the thermoelectrons discharged by filament 56c spin inside the active space formed between vanes 52 and filament 56c, generating a microwave. This microwave, flowing along a vane 52, is transferred to antenna 58 connected to vain 52. The microwave is then discharged externally through antenna 58.

Anode cylinder 51 and metal container 54 are bonded by tightly welding thin end section 59 of anode cylinder 51. Referring to Fig. 5(a), before the welding operation, thin end section 59 of anode cylinder 51 has a roughly even thickness between end 59a and base section 59b. Magnetic piece 53 and metal container 54 are placed on an inner shelf of thin end section 59.

Referring to Figs. 4 and 5(b), thin end section 59 of anode cylinder 51 is melted by welding to form a tight bond with outer perimeter bend 54a of metal container 54.

If a slight gap forms between the inner wall surface of thin end section 59 of anode cylinder 51 and outer perimeter bend 54a of metal container 54 due to dimensional tolerances, misalignment of the parts, or the like, this gap will remain, even after the tight welding. This can lead to reduced sealing properties. Discarding such assemblies results in increases material costs, while performing repairs of these assemblies increases the number of steps involved in the procedure.

To prevent these gaps, the parts may be formed with shapes that provide alignment relative to each other. If alignment between the parts is not possible, dedicated tools or equipment may be used to secure the parts while welding. However, with each of these methods there is an increase in production costs.

OBJECTS AND SUMMARY OF THE INVENTION

It is an object of the present invention to provide a method for making a magnetron which overcomes the foregoing problems.

More specifically, it is an object of the present invention to provide a method for making magnetrons that easily improves the quality of the tight welding operation.

Briefly stated, the present invention provides a magnetron having an anode cylinder, a plurality of vanes arranged radially within the anode cylinder, a magnetic piece disposed at an open end section of the anode cylinder, an anode

vacuum container including a metal container disposed to cover an upper surface of the magnetic piece, a cathode disposed along a central axis of the vacuum container, and an antenna externally discharging microwaves. The magnetic piece and the metal container are placed, in that order, on a shelf formed inwardly on a thin end section projecting from the open end section of the anode cylinder. When tightly welding the thin end section, a predetermined number of projections, projecting inwardly from the thin end section of the anode cylinder, loosely secure an outer perimeter bend of the metal container. The metal container is then accurately tightly weld to the anode cylinder without the metal container shifting off-center.

According to an embodiment of the present invention, a method for making magnetrons includes a magnetron having an anode cylinder, a plurality of vanes arranged radially within the anode cylinder, a magnetic piece disposed at an open end section of the anode cylinder, an anode vacuum container including a metal container disposed to cover an upper surface of the magnetic piece, a cathode disposed along a central axis of the vacuum container, and an antenna externally discharging microwaves. The magnetic piece and the metal container are placed, in that order, on a shelf formed inwardly on the thin end section projecting from the open end section of the anode cylinder. When tightly welding the thin end section, a predetermined number of projections projecting inwardly from the thin end section of the anode cylinder is used to loosely secure an outer perimeter bend of the metal container.

According to another embodiment of the present invention, a method for making magnetrons includes providing a magnetron having an anode cylinder, a plurality of vanes arranged radially within the anode cylinder, a magnetic piece

disposed at an open end section of the anode cylinder, an anode vacuum container including a metal container disposed to cover an upper surface of the magnetic piece, a cathode disposed along a central axis of the vacuum container, and an antenna externally discharging microwaves. The magnetic piece and the metal container are placed, in that order, on a shelf formed inwardly on the thin end section projecting from the open end section of the anode cylinder. When tightly welding the thin end section, a ring-shaped projection, projecting inward from the thin end section of the anode cylinder, is used to loosely secure an outer perimeter bend of the metal container.

The above, and other objects, features and advantages of the present invention will become apparent from the following description read in conjunction with the accompanying drawings, in which like reference numerals designate the same elements.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a schematic cross-section drawing showing an embodiment of a magnetron according to the present invention.

Fig. 2 (a) is a schematic cross-section drawing showing a magnetron, according to the present invention, before elements are loosely secured.

Fig. 2 (b) is a schematic cross-section drawing showing a magnetron, according to the present invention, after elements are loosely secured.

Fig. 3 (a) shows a state of a magnetron, according to another embodiment of the present invention, before elements are loosely secured.

Fig. 3 (b) is shows a state of a magnetron, according to another embodiment of the present invention, after elements are loosely secured.

Fig. 4 is a schematic cross-section drawing showing an example of a conventional magnetron.

Fig. 5 (a) is a cross-section drawing of a conventional magnetron before tight welding is performed.

Fig. 5 (b) is a cross-section drawing of a conventional magnetron after tight welding is performed.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to the attached drawings, the following is a description of a method for making magnetrons according to the present invention.

Referring to Fig. 1, a magnetron according to an embodiment of the present invention includes an anode vacuum container 1. A cathode 2 is disposed along the central axis of container 1. An antenna 3 extracts microwaves generated in a hollow manner. The magnetron further includes an antenna ceramic 4 and cathode supports 5a, 5b.

Anode vacuum container 1 includes a cylindrical anode cylinder 6. A plurality of vanes 7 are arranged radially inside anode cylinder 6. Magnetic pieces 8, 9 are disposed at the upper and lower openings of anode cylinder 6. Metal containers 10, 11 cover the upper surfaces of magnetic pieces 8, 9.

Cathode 2 includes an end hat 12 secured to the end of cathode support 5a. A top hat 13 is secured to the end of cathode support 5b, which passes through

end hat 12. A filament 14 is wrapped around cathode support 5b between top hat 13 and end hat 12.

Thin end section sections 6a, projecting from the ends of the upper and lower openings of anode cylinder 6, are tightly welded to outer perimeter bends 10a, 11a of metal containers 10, 11. This forms a tight bond between metal containers 10, 11 and anode cylinder 6.

Next, the procedure for tightly welding outer perimeter bends 10a, 11a of thin end sections 6a will be described. To facilitate the discussion, the tight welding between thin end section 6a, projecting from the end of the upper opening of anode cylinder 6, to outer perimeter bend 10a will be described.

Referring now to Fig. 2(a), anode cylinder 6 is prepared as a cylindrical material with upper and lower openings from the ends of which are projected ring-shaped thin end sections 6a. Magnetic piece 8 and metal container 10, having a bent outer perimeter, are placed, in that order, on a shelf 15, formed on the inner side of thin end section 6a. Then, a projection tool 17, on which a projection 16 having a predetermined shape, is placed at the outer side of anode cylinder 6, opposite from thin end section 6a.

Referring to Fig. 2(b), projection tool 17 is impacted on thin end section 6a of anode cylinder 6, forming an inward projection 18 on thin end section 6a. Inward projection 18 abuts outer perimeter bend 10a. It would be desirable to form at least three inward projections 18 along the perimeter so that metal container 10 stays centered. Next, thin end section 6a and outer bend 10a are tightly welded together. This tight welding is performed, for example, by using electron beam welding.

In this embodiment of the present invention, the tight welding operation is performed by loosely securing metal container 10 using projection 18 of thin end section 6a. This prevents metal container 10 from becoming off-center, allowing accurate welding of metal container 10 to thin end section 6a. As a result, a tight seal is formed and maintained between anode cylinder 6 and metal container 10. Metal container 10 is supported by laterally projecting projection 18. Metal container 10 is loosely secured in a reliable manner even if the end surface of projection 18, formed on thin end section 6a, is positioned lower than the upper surface of metal container 10. As a result, the metal container is loosely secured even without increasing the height of anode cylinder 6. This reduces the material costs for anode cylinder 6.

In this embodiment of the present invention, the projection is formed by first positioning the magnetic piece and the metal container and then using the projection tool placed outside the thin end section of the anode cylinder. However, the present invention is not restricted to this specific embodiment. It would also be possible, for example, to first place the magnetic piece at an open end of the anode cylinder, on which is formed a predetermined inward projection positioned opposite from the thin end section. Then, the metal container would be positioned, and the outer perimeter bend of the metal container would be pressed into the projection, thus assembling the elements before making the tight weld.

Referring now to Fig. 3(a), it is also possible to place, on the opening of anode cylinder 6, magnetic piece 8 and a metal container 21, on which is formed a predetermined number of holes 22 along outer perimeter bend 21a. Then,

projection tool 17 is placed outside of anode cylinder 6, opposite from thin end section 6a.

Referring to Fig. 3(b), projection tool 17 is aligned with hole 22 and impacted against thin end section 6a of anode cylinder 6. Thin end section 6a forms inward projection 18. Inward projection 18 is inserted into hole 22. It is desirable to have at least three inward projections 18 and holes 22 engaged at the same time along the perimeter so that metal container 21 stays centered. Then, thin end section 6a and outer perimeter bend 21a are tightly welded.

In this embodiment of the present invention, inward projection 18 of thin end section 6a loosely secures metal container 21, thus keeping metal container 21 centered, allowing accurate welding of thin end section 6a and metal container 21. This provides a tight bond between anode cylinder 6 and metal container 21. Metal container 21 is supported by laterally projecting inward projection 18. Thus, as with the embodiment described above, loose securing is achieved without increasing the height of anode cylinder 6. As a result, the material costs for anode cylinder 6 are reduced.

In these embodiments, the outer perimeter bend of the metal container is loosely secured by a predetermined number of projections projecting inward from the thin end section of the anode cylinder. The present invention is not restricted to this, however, and it would also be possible to loosely secure the outer perimeter bend of the metal container using a ring-shaped projection projecting inward from the thin end section of the anode cylinder.

As described above, the present invention allows improved welding for the assembly of the main magnetron unit. Additional, the present invention provides a tight bond between the anode cylinder and the metal container.

Having described preferred embodiments of the invention with reference to the accompanying drawings, it is to be understood that the invention is not limited to those precise embodiments, and that various changes and modifications may be effected therein by one skilled in the art without departing from the scope or spirit of the invention as defined in the appended claims.